waste input in this area reduces DO levels to well below the 4.0 ppm daily average established as the EPA Water Quality Criterion for the Protection of Aquatic Life. In the middle and lower reaches of the estuary, DO levels begin to increase to a point where they equal or exceed the EPA Criterion.

Surface DO concentrations observed in the Morgantown SES region have been consistently higher than the EPA minimum. Average surface DO values during 1967-1970 ranged from approximately 5.0 ppm in July through September to over 13.0 ppm in the winter months (EPA Storet data). Measurements taken in the Morgantown vicinity in summer of 1970 (STP Associates, 1971) showed that surface DO values at points within a few thousand feet of each other varied as much as 4.4 ppm (5.3 - 9.7 ppm), a phenomenon unrelated to nutrient loading or biological activity.

DO levels generally decrease with increasing depth in most estuaries. Values of only 1.1 - 4.0 ppm were observed at bottom stations near Morgantown during July, 1970; but, in the summer of 1974, average monthly DO levels of deep intake waters at Morgantown had increased to 3.78 - 5.89 ppm. Depressed bottom levels in summer are not considered to affect overall water quality or constitute a plant impact.

d. Heavy Metals

Sediments and their interstitial waters retain dissolved chemicals which may affect growth and reproduction of aquatic organisms in general, and benthic organisms in particular. Until recently, the major concentrations of heavy metals occurring in Potomac River sediments were found in and around the Washington, D.C. metropolitan area (Pheiffer et al., 1972). In studies conducted in 1967-1970 in the vicinity of the Morgantown plant, concentrations of trace metals (iron, manganese, copper, nickel, and zinc) were found to be at or below detectable limits (ANSP, 1968, 1969, 1970a). However, river sediment samples taken in 1970 and 1971 showed levels of copper, lead, strontium, chromium, nickel, and zinc to have risen, especially around the sites of two power plants, Possum Point and Morgantown.

The Environmental Protection Agency reported (Pheiffer, 1972; Houser and Fauth, 1972) that a sediment sample taken near the Morgantown SES in December 1970, just after the plant began operations, contained 25 ppm copper, while a sample taken from the same location in April 1971 contained 731 ppm copper. Electrochemical corrosion of copper from Morgantown condenser tubing was considered as a cause of the increased sedimentary copper levels (O' Connor, 1976), but was deemed unlikely because of the large amounts of metal involved. Houser (personal communication) has indicated that the most probable cause of the 731 ppm copper level was droppings from anti-fouling paint which had been applied to the Route 301 bridge a week before sampling.

A more recent investigation of sedimentary heavy metal levels near Morgantown (O' Connor, 1976) found copper levels between 2 and 39 ppm. On the basis of experimentally determined ratios between copper and zinc levels in sediments, it was suggested that a small enrichment in copper levels may have occurred in sediments close to and upstream of the plant cooling water discharge. Although further investigation of sediment in this area is necessary to clarify the role of the Morgantown plant in altering heavy metal concentrations, results to date do not identify the plant as a major source of heavy metal contamination in the river.

e. Chlorination

The survival, reproduction, and behavior of aquatic organisms have reportedly been affected at relatively low levels of exposure to chlorine (Beauchamp, 1969; Hamilton et al., 1970; Arthur and Eaton, 1971; Brungs, 1973). (See also Part B of this Section.) Thus, the effects on aquatic organisms of the large amounts of chlorine discharged by Potomac River sewage treatment plants and power plants are a concern.

Approximately 2.75 million gallons per day (mgd) of water containing 32,000 lbs/day of chlorine are discharged into the Potomac from both types of sources. Comparison of chlorine discharges per 5-mi river segment (Tables VII-1 and VII-2) shows a significantly higher discharge from the area above river mile 90 than anywhere else along the estuary. Over 85% of all chlorine introduced into the river comes from the Washington metropolitan area, with Blue Plains sewage treatment facility discharging almost six times as much as the other sources combined.

Morgantown is too far downstream from Washington area chlorine sources to be affected by them: chlorine discharges are quickly diluted and dissipated. But there is a possibility that chlorine and chlorine residuals from the Morgantown plant itself could cause some damage to local communities of biota around the plant site. (See Sections II, V and VI.)

f. Thermal Discharges

In addition to chemical pollutants, extra heat is added to the Potomac by the five power plants located on its shores. Modern fossil fuel power plants operate at about 34% efficiency, i.e., about 10,000 BTU are required to generate 1 kwh of electricity (Parker and Krenkel, 1969). Since the thermal equivalent of 1 kwh is 3,413 BTU, approximately 6587 BTU/kwh generated are released as heat -- some to the atmosphere, but most to the plant cooling water. The waste heat generated by the five major power facilities located along the Potomac is currently nearly 4×10^{11} BTU/day, on the order of 0.05 percent of solar influx to the surface of the Potomac over its estuarine portion.

In order to compare waste heat inputs of the various plants, rated capacities and heat release rates reported by Dangard and Sundaram (1973) were used. As shown in Table VII-3, the three generating stations in the Washington area contribute approximately the amount of

TABLE VII-1

Chlorine and Water Discharge by Municipal Sewage Treatment Facilities per 5-mi Segment in the Tidal Portion of the Potomac River

River Mile	Water Discharges (mgd)	Lbs Chlorine Discharged/day
95+ (Blue Plains)	280,000	27,440
85-90	-------	------
80-85	16,770	1,640
75-80	.010	1
70-75	1.606	160
65-70	-------	------
60-65	-------	------
55-60	-------	------
50-55	-------	------
45-50	.078	8
40-45	.060	6
35-40	-------	------
30-35	.092	10
25-30	.055	98
20-25	.300	30
15-20	-------	------
10-15	.080	8
5-10	.096	10
0-5	-------	------
Total	299,147	Total 29,405

Source: State of Maryland, Maryland Dept. Nat. Res., 1972.

TABLE VII-2

Chlorine and Water Discharge by Generating Stations at Various 5-mi Segments in the Lower Potomac River

River Mile	Water Usage (mgd)	Lbs Chlorine Discharged/day
90 + Anacostia River (Benning Road) (Buzzard Point) (Potomac River)	622.3	806.7
65-70 (Possum Point)	400.0	0.082
40-45 (Morgantown)	1,434.0	1,890.4
Total	2,656.3	Total 2,697.182

heat to that segment of the river as Morgantown does to its 5-mi segment. Thermal effects from power plants upstream have dissipated well before they reach Morgantown. Only thermal discharges from the plant itself are likely to affect organisms in the region.

TABLE VII-3

Waste Heat Discharge per 5-mi River Segment from Once-Through Cooling by Power Generators

River Mile		Waste Heat (Q) (BTU/day)
90 + Anacostia River	(Benning Road)	1.6×10^{11}
	(Buzzard Point)	
	(Potomac River)	
65-70	(Possum Point)	7.6×10^{10}
40-45	(Morgantown)	1.6×10^{11}
	Total	4×10^{11}

B. Distributions of Aquatic Biota in the Potomac River and Potential Plant Impact on Commercial Fisheries

Potential for biological impact by the Morgantown plant depends on the population levels of organisms distributed in the region of the plant which are susceptible to power plant effects. The lower phyla, primarily planktonic, are entrainable but relatively disjunct from similar communities in other regions of the river; thus, direct system-wide implications of point-source perturbation are limited. In most instances, benthic forms are also directly affected only within a limited region. However, detrimental changes in any habitat for a valuable resource may be significant to the yield maintenance of that resource. Therefore, the relationship of distributions of economically important finfish and shellfish at the Morgantown site to river-wide distributions are examined for qualitative evaluation of plant impact.

In terms of regional impact of the Morgantown site, the most important considerations are the higher nektonic forms, finfish in particular. Because of their seasonal migratory and spawning habits, river-wide distributions of important fishes must be delineated before potential effects of the plant -- whether from entrainment, entrapment, or impingement -- can be examined.

1. Primary and Secondary Producers

a. Phytoplankton

Abundances of primary producers in the Potomac are indicated by the concentrations of chlorophyll a shown in Figure VII-7. However, the value of various types of primary producers to higher trophic levels of the food chain is not consistent. Certain blue-green algae, produced in large amounts in the area below Washington, D.C. during the summer, are not consumed by important herbivores in the river, such as zooplankton. Thus, areas depicted as having high chlorophyll a concentrations (and therefore an abundance of primary producers) may contribute less to the higher trophic levels than areas having much lower chlorophyll a concentrations.

Community structure at Morgantown (ANSP, 1971c; Mulford, 1974) displays seasonal shift of dominance among various phytoplankton groups. During studies at Morgantown from 1969 to 1970 (ANSP, 1971c), diatoms were dominant most of the year with greatest densities in early winter. In late winter and early spring, total cell concentrations dropped from early winter highs of over 100,000 cells/liter to only 59 to 500 cells/liter. As warmer conditions developed, blue-greens and greens increased. During these studies, early summer communities were dominated by dinoflagellates, and densities approached those of winter highs. Heavy blooms of the most common blue-green, *Anacystis cyanea*, did not appear until August, peaking in September. Similar annual patterns have been reported from the Douglas Point region of the river (NUS, 1973; EAI, 1974) although dinoflagellates were virtually absent.

The various studies over the years at Morgantown indicate that phytoplankton populations in this region of the river are similar to those found in other portions of the Bay, both in community structure and the patchiness of their distributions (Flemer, 1970; ANSP, 1971a; Lippson, 1973). Patchiness in phytoplankton populations was evident during the Morgantown studies, with differences of as much as 60% observed in any one sampling period. Seasonal shifts of vertical distributions were also observed, with the greatest number appearing at the surface in summer months. Patchiness and vertical shifting have been considered in evaluating results of entrainment studies (Bongers et al., 1973).

b. Zooplankton

No extensive river-wide surveys of the zooplankton populations of the Potomac River have been conducted. Two detailed studies were done in the area of the estuary around Douglas Point (NUS, 1973; EAI, 1974). In general, findings in both were similar. The most abundant and frequently collected zooplankton was the freshwater cladoceran, *Bosmina longirastris*, while the remaining biomass collected consisted primarily of three copepods (*Eurytemora*, *Mesocyclops* and *Acartia*) and a rotifer (*Brachionus*). *Bosmina* was most abundant in the transects above Douglas Point, as was *Brachionus* and *Mesocyclops*. *Acartia* and *Eurytemora* tended to be most abundant below Douglas Point. Douglas Point appeared to be a natural demarcation line above which freshwater species dominate and below which more saline-tolerant forms were most abundant. Seasonal changes in abundance of all these species were observed (EAI, 1974). *Eurytemora* showed highest densities in April, while *Acartia* was most abundant in July.

Morgantown entrainment studies conducted in 1972 revealed that Eurytemora, Acartia, and Scottolana were the three dominant copepods in that region (Heinle and Millsaps, 1973), and that they followed the same general seasonal abundance patterns observed near Douglas Point. In general, the data available suggest that the zooplankton community in the Morgantown area is typical of that found in low salinity (<5 ppt) estuarine waters throughout the Chesapeake Bay (EAI, 1974) and has a wide river distribution encompassing the site. Therefore, entrainment and nearfield damage described in Sections V and VI of this report is not significant system-wide.

2. Macroplankton

Other zooplankton present in the Potomac estuary are the macroplankton, which include ctenophores (combjellies), sea nettles (jellyfish), and opossum shrimp (Neomysis), as well as amphipods of several genera, larvae of other invertebrates, and fish eggs and larvae. Distributions of fish eggs and larvae and probable distributions of invertebrate larvae of commercially important species are discussed in Part 3 of this section, below.

Combjellies were reported in great abundance at the Morgantown site by Mihursky et al. (1973b), but their distribution in the estuary as a whole is not well documented. They are often extremely abundant in the Bay and range to salinities as low as 4 ppt (Lippson, 1973). The sea nettle is also often abundant, but restricted to salinities greater than 5 ppt (Lippson, 1973). They appear in abundance in the Morgantown area (Mihursky, 1973b) and may be a major source of cropping of other planktonic organisms.

The opossum shrimp (Neomysis), a crustacean, is consumed as forage by many species of finfish. The Morgantown site is located within the normal estuarine range of Neomysis, which is usually found at salinities greater than 0.5 ppt (Lauer, 1972). Little can be said concerning amphipods since these organisms have not been identified as to genus (Mihursky et al., 1973b); those collected may have consisted of freshwater as well as marine and estuarine forms. Amphipods in the Morgantown area are more abundant in spring than in summer (Mihursky et al., 1973b).

Plant operations at the Morgantown SES appear to have little effect on populations of macroplankton (Richkus and Lippson, 1975); and, because of their high recovery capability, there is little likelihood that local plant-induced decreases in phytoplankton, zooplankton and macroplankton populations would be propagated through higher food chain levels.

3. Finfish

The chief concern about the Morgantown plant is impact on fish and shellfish species that have real or potential value in commercial fishing, or support extensive sport fisheries. If the migratory patterns and spawning and nursery habitats of Potomac finfish can be determined, and the valuable fisheries in the river can be identified, the impact of operations at the Morgantown SES on commercially important species may be inferred.

a. Resources

There are approximately 90 species of fish normally found in the lower Potomac and its tidewater tributaries. Of these, 37 have been recorded in the vicinity of Morgantown. In reality, species abundances at Morgantown are greater than the records indicate: because of varying salinity ranges at the Morgantown site and its proximity to tributary streams, almost any species found within the limits of Potomac tidewaters could potentially be found at Morgantown.

There is no literature reviewing the distributions and spawning areas of all Potomac River fishes, but species composition of adult finfish populations within each of the Potomac River salinity regimes can be predicted from knowledge of the salinity tolerance of each species, its habitat preferences, seasonal migratory patterns, and other species-specific behavioral patterns reported in the literature (R. Mansueti, 1960, 1961; A. Mansueti and Hardy, 1967; ANSP, 1970b; Wiley, 1970; Dovel, 1971; Musick, 1972; Lippson, 1973; NUS, 1973; O'Dell et al., 1973; Scott and Boone, 1973; EAI, 1974). Potomac River fishes can thus be divided into categories according to their normal environmental preferences: estuarine, freshwater, or marine. Certain fishes can be further categorized according to migratory spawning habits (anadromous or catadromous). Fishes within a group can be further separated according to the ranges of their salinity tolerances and their preferences for mainstem or tributary waters.

The 1974 ichthyoplankton survey (Potomac River Fisheries Program - PRFP) has provided new and valuable information on both the qualitative and quantitative aspects of ichthyoplankton distributions in the Potomac. Prior to these results, only more limited data was available. For instance, the Maryland Fisheries Administration, in cooperation with the Annapolis Field Office of the Environmental Protection Agency, conducted weekly plankton tows for a number of years; and the Anadromous Fish Program of 1970-1971 (O'Dell et al., 1973) included plankton collections in both the Potomac mainstem and tributaries. No volumetric water measurements were taken in these two studies, making quantitative comparisons among the programs unfeasible. However, by integrating species distributions found during the PRFP study with those found in the more limited surveys, spawning and nursery areas for most of the Potomac generally can be delineated (at least qualitatively).

The results of the ichthyoplankton surveys and documented distribution records can then be used to determine distributions of life stages of each fish in the Potomac and at Morgantown. In the few cases where eggs and larvae of a species have not been collected, spawning areas are inferred from salinity ranges in which early life stages occur in other areas of the Chesapeake Bay (Dovel, 1971).

(1) Anadromous Fishes

Anadromous fishes are those which ascend rivers or streams from the ocean or the estuary to spawn in fresh or low-brackish waters. The anadromous group includes more of the important commercial and sport species than any other group. Table VII-4 lists the anadromous fishes recorded at Morgantown, and Figure VII-9 shows their distributions.

TABLE VII-4

Anadromous and Catadromous Fishes

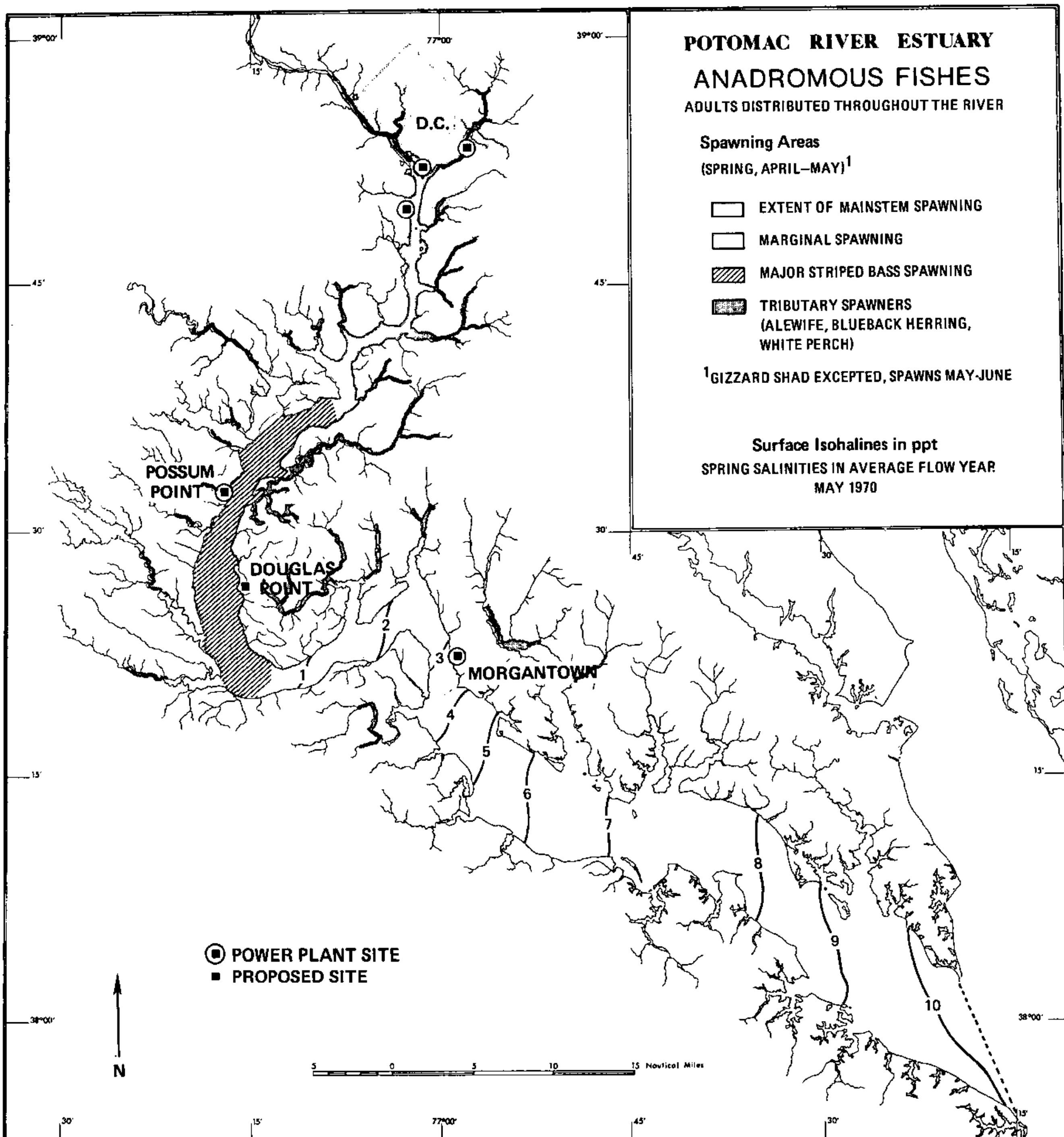
of the Potomac Estuary

Anadromous Fishes	Recorded from Vicinity of: Morgantown	Douglas Pt.	Reported Salinity Range in ppt[1]
Striped bass	x	x	0 - 30+
White perch	x	x	0 - 25
American shad		x	0 - 30+
Hickory shad			"
Blueback herring	x	x	"
Alewife	x	x	"
Gizzard shad	x	x	0 - 29
Atlantic sturgeon		x	0 - 30+
*Shortnose sturgeon			"
Catadromous			
American eel	x	x	0 - 30+

[1] Musick, 1972

* Rare and endangered species

Striped bass and shad are mainstem spawners, migrating at times as far upstream as Washington, D.C. (Davis et al., 1971; O'Dell et al., 1973). Shad generally prefer shallow shoals for spawning, while striped bass tend to select deeper regions. The 1973 ichthyoplankton survey of tributaries (Loos, 1975) has documented the historical assumption that striped bass do not spawn in tributaries and that the center of mainstem spawning activity of striped bass, white perch, and herrings in the Potomac is above Morgantown. The herring species and white perch utilize both the tributaries and the mainstem for spawning, but prefer the tributaries. One of the herring -- the alewife (*A. pseudoharengus*) -- generally moves farther upstream, usually into waters



VII-9. Spawning regions of anadromous fishes in the Potomac estuary. Source: Mansueti and Hollis, 1963; Dovel, 1971; Musick, 1972; O'Dell et al., 1973; NUS, 1973; EAI, 1974; Lippson and Moran, 1974.

of less than 1 ppt salinity, than the other herring, blueback (*A. aestivalis*), or the white perch (O'Dell et al., 1973; Davis et al., 1971; Loos, 1975). Although Morgantown is close to major tributaries (Port Tobacco River -- river mile 49, Nanjemoy Creek -- river mile 53.5, and the Wicomico River -- river mile 31), downstream migrating larvae have not been found passing the plant site. The gizzard shad, also a strong mainstem spawner, tends to spawn farther upstream than the striped bass and shad and about a month later than the other anadromous fishes. Gizzard shad spawning was evident in the late upstream peak of clupeid eggs and early larvae observed above Douglas Point in 1974 (EAI, 1974). No gizzard shad eggs or larvae have been identified in the Morgantown region.

River-wide and seasonal distributions of juvenile stages cannot be quantified at this time from existing data. However, from various surveys in the Potomac (Scott and Boone, 1973; O'Dell et al., 1973; ANSP, 1970b;EAI, 1974), some general patterns do emerge. White perch juveniles are more heavily concentrated above Maryland Point both in the mainstem and the tributaries (Loos, 1975; Scott and Boone, 1973). Striped bass juveniles tend to be distributed throughout the mainstem; some few juveniles have been collected in the fall as far upstream as Mattawoman Creek (river mile 73.5) (O'Dell et al., 1973), but heavier concentrations occur downstream from Maryland Point. Juvenile herrings and shad apparently remain well upstream in tidal-fresh and low-brackish waters into September (Scott and Boone, 1973). According to known behavior patterns (Hildebrand and Schroeder, 1928), these young-of-the-year move downstream in late fall, some over-wintering in the lower river or Bay, others migrating into the ocean.

In spring months, adult anadromous fishes are concentrated above Morgantown in tidal fresh or low-brackish waters (Fig. VII-9), and migratory schools pass Morgantown en route to or from spawning grounds. The proximity of Morgantown to the fresh-saltwater interface, and, thus, to the center of anadromous spawning activity, varies from year to year.

Adult alewives and shad are found in the Potomac for a period of only three to four months, March through June. The shad move quickly in and out of the spawning grounds, while the alewives tend to lag behind. Adults of the other anadromous species are year-round residents. Striped bass occur throughout the river in the summer months, but generally are concentrated below the Rt. 301 bridge. Since adult striped bass are not sampled comprehensively by present collecting methods or commercial catch data, quantitative comparison of densities in each region of the river is not possible. It is hoped that new methodologies, in particular acoustic surveys, will provide this information in the future (Zankel et al., 1975). In winter, striped bass move downriver to overwinter in deeper waters (Nichols and Miller, 1967; Mansueti, 1956). Although some Potomac River striped bass migrate during this season into the Atlantic, most remain in Maryland's Chesapeake Bay, returning to the Potomac to spawn (Nichols and Miller, 1967).

Adult white perch tend to be distributed more evenly throughout the oligohaline and mesohaline regions than striped bass. This ubiquitous distribution is reflected in commercial catch records and follows similar distributions of white perch populations found in the Patuxent (Mansueti, 1961). Fishery records seem to indicate that gizzard shad tend not to descend to the mouth of the Potomac. However, they do range at least down to Morgantown as evidenced by the large catches by gill nets at the Morgantown station in the 1974 Spawning Stock Assessment Program (Wilson et al., 1974).

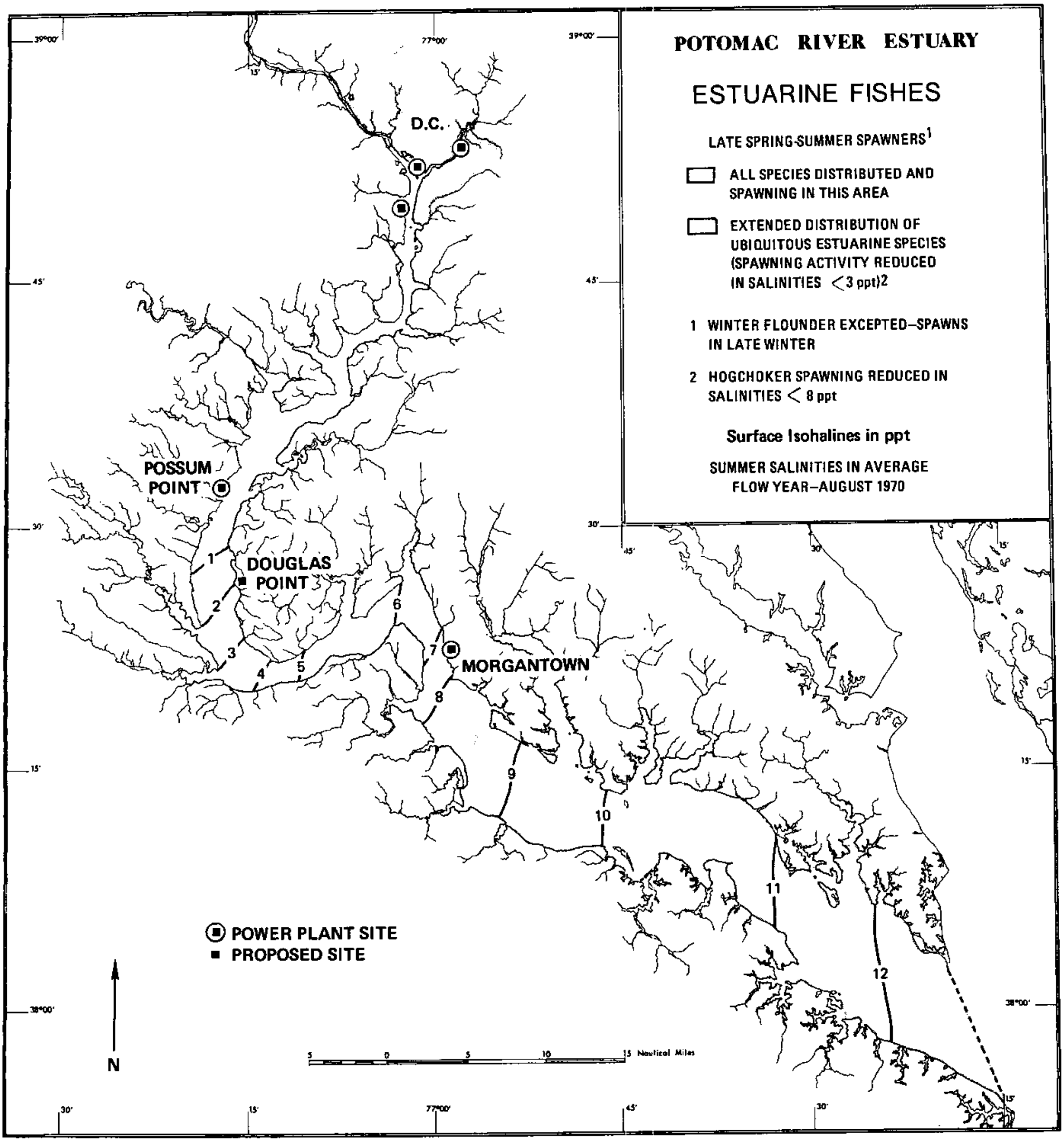
The only catadromous fish in the Potomac is the American eel, which displays migrational behavior opposite to that of anadromous fishes; i.e., eels migrate from fresh or estuarine waters to the ocean to spawn. They are abundant and ubiquitous, being found in every part of the Potomac and its tributaries.

(2) Estuarine Fishes

Estuarine fishes normally reside within estuarine boundaries between tidal freshwaters and the ocean. These year-round residents include two groups. The first and larger grouping consists of the ubiquitous estuarine species distributed throughout all tidewaters of the Potomac system. These fishes have high tolerance for very low-saline or fresh waters. The other grouping, mesohaline estuarine species, have more limited salinity tolerances and are rarely found in waters less than 8-9 ppt. Mesohaline estuarine species are found principally in regions of the river below Morgantown. Distributions of these groups in the Potomac are shown in Fig. VII-10.

There are 21 estuarine species recorded in the Potomac River (Table VII-5). Most are small fishes inhabiting shallow shoreline or oyster bar communities. (By definition, striped bass, white perch, and gizzard shad also are estuarine fishes but are defined as anadromous because of their distinctive spawning migration behavior.) Such specific habitat-oriented fishes rarely move great distances, with the result that any localized environmental perturbations,such as those caused by a power plant, would affect only a small portion of the total river population.

Some estuarine species -- anchovies and silversides, for example -- are forage fish for Maryland's commercial fisheries. Schools of these species range from Washington, D.C. to the river mouth and are heavily preyed upon by such carnivorous fishes as striped bass and bluefish. They spawn over the whole Potomac during a protracted spawning season which runs from late spring into the fall (Lippson and Moran, 1974; Dovel, 1971). Most anchovy spawning occurs in salinities between 3 and 16 ppt, resulting in little spawning above Maryland Point. The Morgantown site is located just below the upper limits of the spawning grounds of the bay anchovy, according to 1973 and 1974 river surveys (EAI, 1974; Mihursky et al., 1974a, b).



VII-10. Distribution of estuarine fishes in the Potomac estuary. Source: ANSP, 1970b; Dovel, 1971; Musick, 1972; O'Dell et al., 1973; Scott and Boone, 1973; NUS, 1973; EAI, 1974; Lippson and Moran, 1974.

TABLE VII-5

Estuarine Fishes of the Potomac River Estuary

UBIQUITOUS ESTUARINE SPECIES

Common Name	Recorded from Vicinity of Morgantown	Recorded from Vicinity of Douglas Pt.	Reported Salinity Range in ppt[1]
Bay anchovy		x	1 - 33
Atlantic needlefish	x		0 - 33
Sheepshead minnow	x		0 - 32.8
Marsh killifish			
Banded killifish	x	x	0 - 20
Mummichog	x	x	0 - 32
Striped killifish	x		0 - 32
Rainwater killifish	x		0 - 31.2
Rough silverside	x	x	0 - 24
Tidewater silverside	x	x	0 - 35.5
Atlantic silverside	x	x	0 - 31
*Threespine stickleback			0 -
Northern pipefish	x		0 - 30
Naked goby	x	x	0 - 27
Hogchoker	x	x	0 - 32

MESOHALINE ESTUARINE SPECIES

Common Name	Recorded from Vicinity of Morgantown	Recorded from Vicinity of Douglas Pt.	Reported Salinity Range in ppt[1]
Oyster toadfish	x		7 - 30
Skilletfish	x		4 26
Fourspine stickleback	x		3 - 26
Dusky pipefish			15 - 30
Striped blenny	x		12 - 25
*Feather blenny			12 - 30
Green goby	x		11 - 13
Winter flounder	x		5 - 30

*Anticipated occurrence although not recorded from the Potomac.

[1] Musick, 1972

Adult bay anchovies are found throughout the river and tributaries from Port Tobacco (river mile 49) to Broad Creek (river mile 92.5) (Loos, 1975).

Silversides, particularly the tidewater variety, generally spawn at salinities of 3 to 7 ppt but can also spawn in tidal-fresh water (Dovel, 1971; Mihursky et al., 1974a, b; EAI, 1974).

Although early developmental stages of both forage species are found at Morgantown in some numbers, entrainment effects on these species are limited by their extended range of spawning activity, i.e., populations in the river are so ubiquitous and prolific that power plant entrainment of larvae has no effect on total river population. (Silverside eggs are attached to substrate on the bottom and are not part of the plankton.)

Two other estuarine species are common in ichthyoplankton samples from the Potomac: the naked goby and the hogchoker. Both are bottom-oriented species of little economic or ecological importance, and both have prolonged spawning periods over a broad region of the river. Hogchokers generally spawn in water above 8 ppt but larvae tend to migrate upstream (along the bottom), congregating in low-salinity nursery grounds. Older larvae gradually migrate back downstream (Dovel et al., 1969). However, few hogchoker larvae have ever been collected at Morgantown. The winter flounder is the only estuarine species of commercial importance found in the Potomac, but spawning occurs in the lower reaches of the river with only occasional stragglers moving upriver as far as Morgantown (Lippson, 1973; Lippson and Moran, 1974).

(3) Marine Fishes

Marine fishes found in the Potomac are normally ocean inhabitants migrating into the river in the summer to feed. There are 23 marine species commonly found in the Potomac (Table VII-6). All are ocean or lower Bay spawners, and most seldom move as far upstream as Morgantown or to salinities lower than 7-8 ppt (Figure VII-11).

Four commercially important marine species -- menhaden, croaker, spot, and bluefish -- have high tolerance for low-salinity waters and are found in the Morgantown area. Late larvae and juveniles of all four fishes move into the Potomac and its tributaries in late winter, spring, and summer. In most instances, by the time they arrive in the Morgantown area, these fish are free-swimming and over 25-30 mm long, i.e., no longer planktonic or entrainable. Loos, (1975) reported concentrations of menhaden collected by plankton nets, beach seines, and trawls from early spring to fall (20 March to 20 September 1974) throughout the mainstem and the tributaries, with the largest populations found in the upper Wicomico (below Morgantown) and Nanjemoy and Potomac Creeks (just above Morgantown).

TABLE VII-6

Marine Fishes of the Potomac River Estuary

SPECIES MODERATELY TOLERANT TO LOWERED SALINITIES

Common Name	Recorded from Vicinity of: Morgantown	Douglas Pt.	Reported Salinity Range in ppt[1]
Striped anchovy	x		30+- 5
Halfbeak	x		30+-12
Lined seahorse			30+-15
Black sea bass			30+-12
Silver perch			30+- 0
Spotted seatrout			30+- 5
Weakfish			30+- 0
Black drum			30+- 0
Red drum			30+-16
Harvestfish			30+- 4
Butterfish			30+- 5
Striped mullet			30+-17
Summer flounder	x		30+- 6
Northern puffer	x		30+- 9

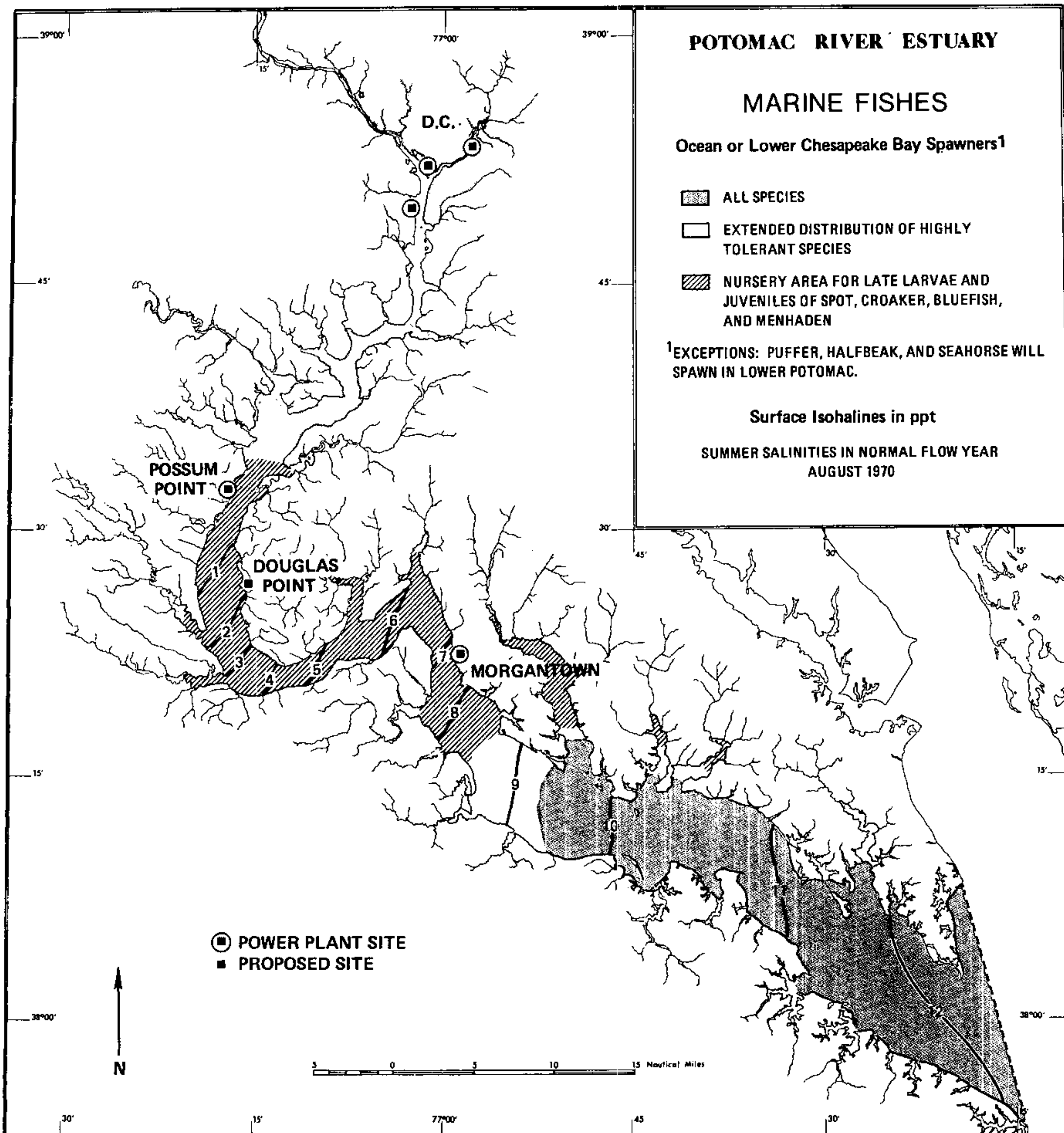
SPECIES HIGHLY TOLERANT TO LOWERED SALINITIES

Atlantic menhaden	x	x	30+- 0
Bluefish	x	x	30+- 1
Spot	x	x	30+- 0
Atlantic croaker	x	x	30+- 0

OCCASIONAL STRAGGLERS

Inshore lizardfish
Cobia
Little tunny
Mackeral
Atlantic bonito

[1] Musick, 1972



VII-11. Distribution of marine fishes in the Potomac estuary. ANSP, 1970b; EAI, 1974; Lippson and Moran, 1974.

Adult croakers, once abundant in the Chesapeake, no longer appear in commercial catches, but juvenile croakers are found regularly throughout the Potomac in late fall and winter. Late croaker larvae produced from the fall ocean spawning move upstream to low-brackish waters in spring and summer. Both stages have been collected at Douglas Point (EAI, 1974) and Morgantown (ANSP, 1970b).

Spot and bluefish populations fluctuate radically, and both juveniles and adults penetrate farther upstream in high than in low population years. Adult spot and bluefish and older juveniles occur at Morgantown during summer and fall months only; late larvae and younger juveniles appear in late winter and spring.

(4) Freshwater Fishes

Over one-third of all fishes in the Potomac estuary are freshwater species (Table VII-7). This is consistent with the fact that approximately one-half of the river is either tidal-fresh or very low-brackish (up to 3 ppt), conditions to which many freshwater species adapt readily. The most salinity-tolerant species move far downstream and are frequently collected at Morgantown. Others, preferring fresher waters, are found primarily in the tributaries or, if found in the mainstem, are usually associated with shallow, vegetated shorelines. Distributions of freshwater fishes by salinity tolerances are shown in Figure VII-12.

All the freshwater species have demersal, attached eggs which are almost always spawned in fresh to tidal-fresh waters. Larval stages remain in nests, or clumps of weeds in well-protected areas, and are not likely to become part of open-water plankton. Yellow perch larvae are an exception: they frequently migrate downstream and are collected by plankton nets in the mainstem currents -- in densities of less than 50 per 1000 m^3, however (Mihursky et al., 1974b).

Morgantown SES should have little impact on freshwater fishes since the plant is located in the mainstem at the upper end of the salinity tolerances of most of these species.

b. Potential for Plant Impact on Commercial Finfish Resources

Of the 90 species of finfish common to the Potomac River, only 21 are commercially fished in significant numbers. Of these, eight species account for 96% of annual average total landings (in pounds). Commercial catches are reported to the Potomac River Fisheries Commission according to the geographical zone of the river in which they were taken (Figure VII-13), and can be broken down by river zone to show the rankings of the eight dominant commercial species for each zone in each season. Figure VII-14 shows the seasonal patterns of abundance for these species for the years 1964-1971.

TABLE VII-7

Freshwater Fishes of the

Potomac River Estuary

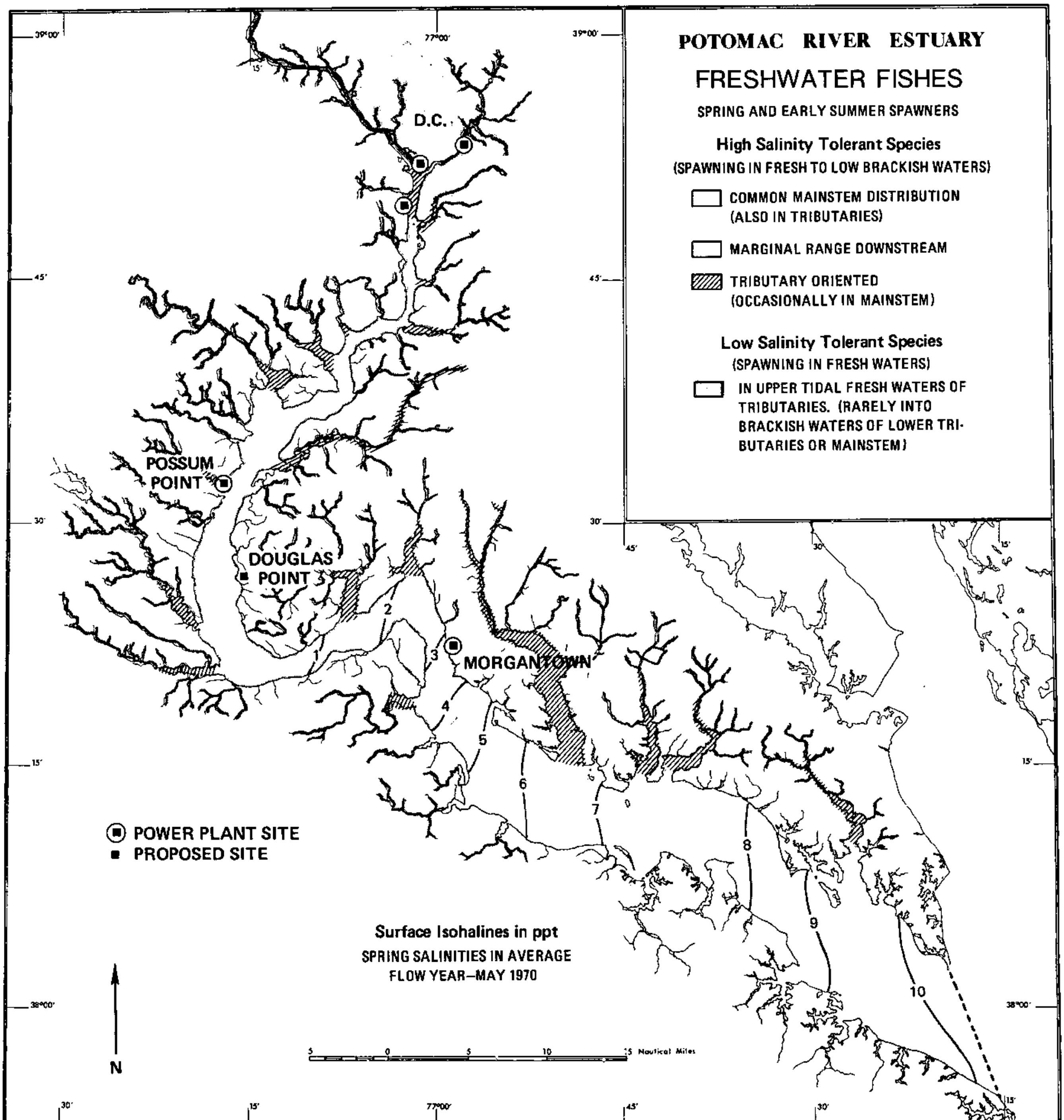
HIGH SALINITY-TOLERANT SPECIES

Common Name	Recorded from Vicinity of: Morgantown	Douglas Pt.	Reported Salinity Range in ppt [1]
Mainstem and Tributary Distribution:			
Longnose gar		x	0 - 23
Threadfin shad		x	0 - 17
Chain pickeral	x	x	0 - 22
Goldfish	x	x	0 - 17
Carp	x	x	0 - 17.6
Silvery minnow	x	x	0 - 14
Golden shiner	x	x	0 - 5.6
Spottail shiner		x	0 - 10.7
White catfish	x	x	0 - 14.5
Brown bullhead		x	0 - 8
Channel catfish		x	0 - 15.1
Yellow perch	x	x	0 - 13
Primarily in Tributaries, Occasionally in Mainstem:			
Mosquitofish	x		0 - 18
Pumpkinseed		x	0 - 18
Bluegill	x		0 - 18
Tessellated darter		x	0 - 13

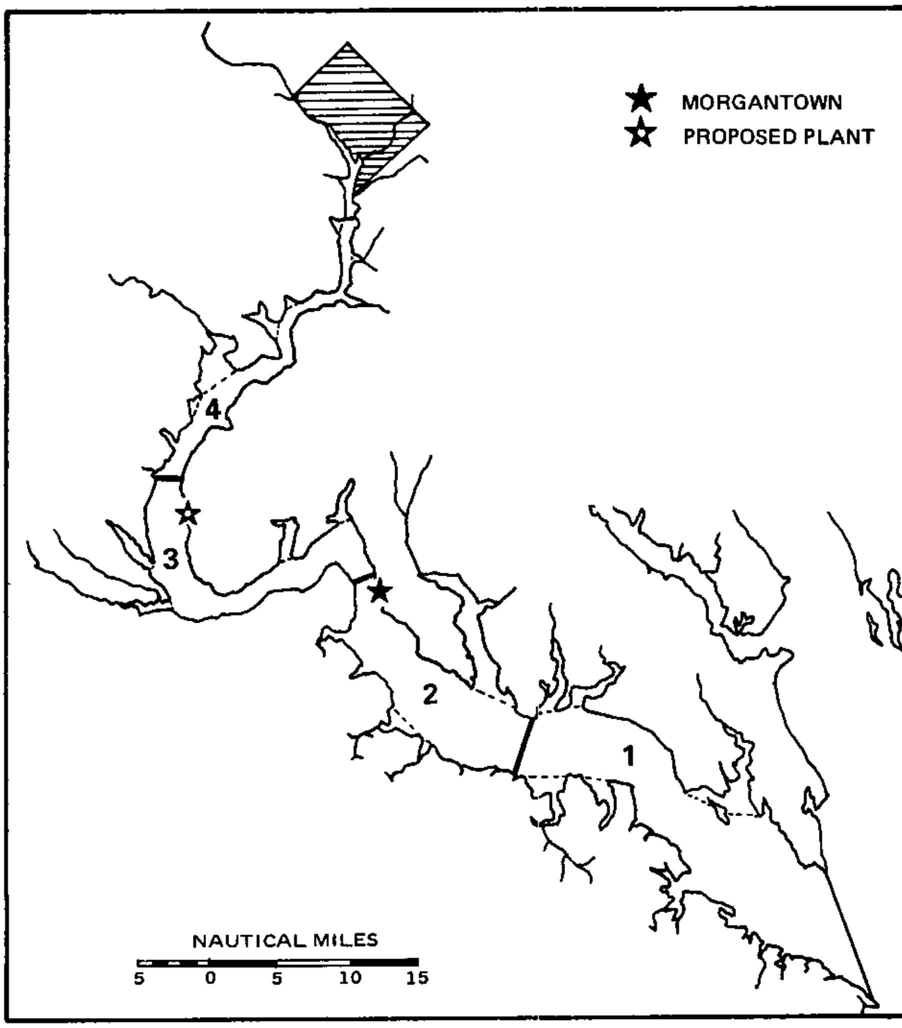
LOW SALINITY-TOLERANT SPECIES

Common Name	Morgantown	Douglas Pt.	Reported Salinity Range in ppt
Eastern mudminnow		x	0 - 4
Redfin pickeral	x		0 - 8.7
Satinfin shiner			0 - 2
Bridle shiner			0 - 11.8
Ironcolor shiner			
Blacknose dace			
Fallfish			
Northern creek chub	x		
Quillback			0 - 10.7
White sucker			0 "brackish"
Creek chubsucker			0
Northern hogsucker			0 "brackish"
Yellow bullhead		x	0
Margined madtom			0
Bluespotted sunfish			0 - 12.9
Redbreast sunfish		x	0
Longear sunfish			0
Largemouth bass		x	0 - 12.9
Black crappie		x	0 - 1

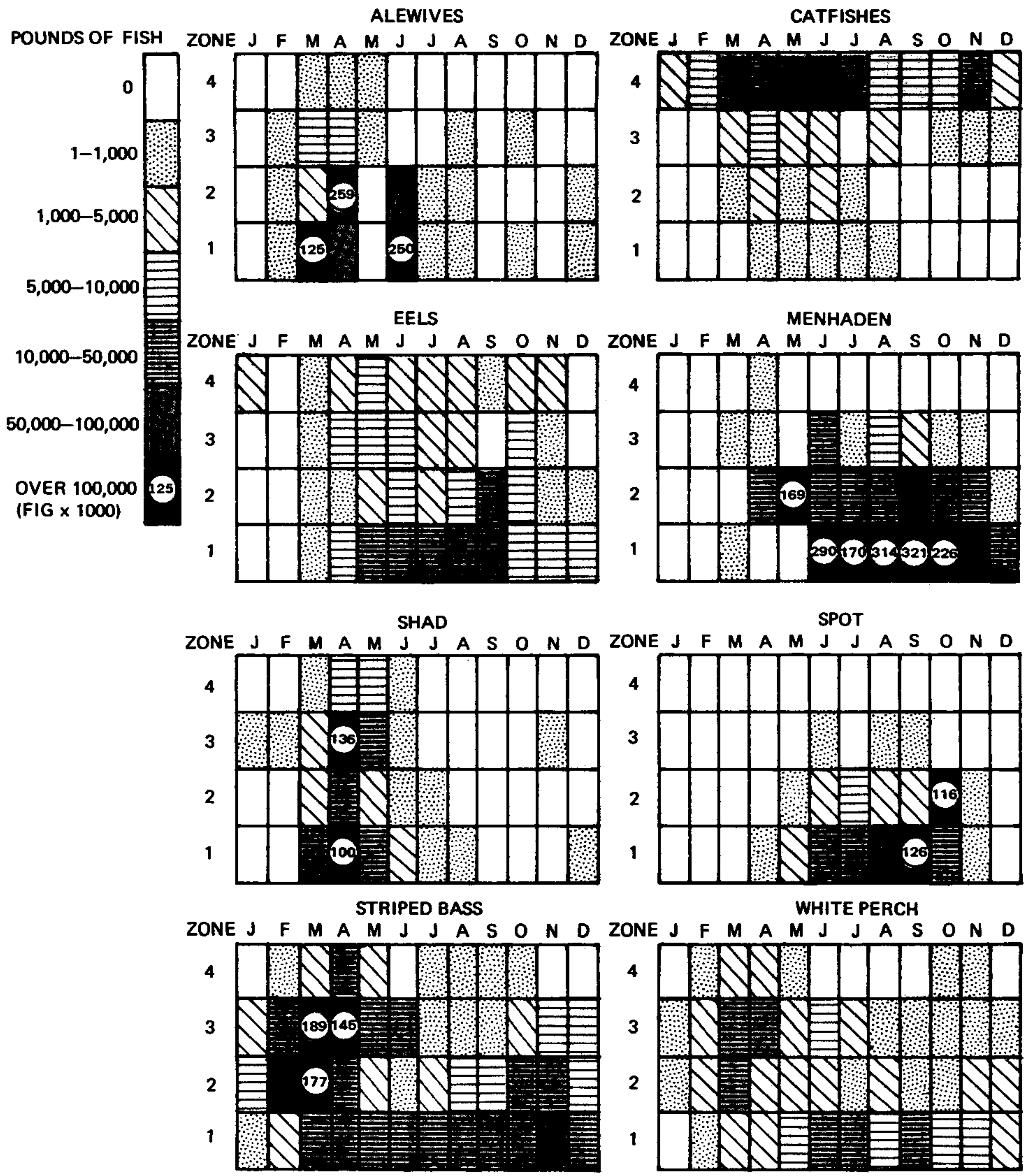
[1] Musick, 1972



VII-12. Distribution of freshwater fishes in the Potomac estuary. Source: ANSP, 1970b; Dovel, 1971; Musick, 1972; O'Dell et al., 1973; Scott and Boone, 1973; NUS, 1973; EAI, 1974; Lippson and Moran, 1974.



VII-13. Zones for reporting commercial fisheries catches in the Potomac River.



VII-14. Average commercial landings by zone in the Potomac River: 1964-1971. Source: de Kok, 1975.

The high catches of anadromous species occur in the spring in the three lower zones where they come to spawn. Shad enter and leave the river over a short time period, while alewives apparently lag behind by about a month before descending to the mouth of the river (Zone 1). Although striped bass are heavily fished while in the spawning grounds in Zones 2 and 3, they are also caught in high numbers through the year and in all zones. White perch catches indicate similar river-wide distributions, although total poundage is less than for striped bass.

The two high-ranking marine species, menhaden and spot, show an entirely different river zone distribution with season: they generally appear in the fishery in summer and fall in the lower zones. However, the river region above Morgantown regularly shows some heavy summer harvesting of these species. The catfish is the one freshwater species in the group of commercially important fish and, as would be expected, is caught primarily in tidal-fresh water (Zone 4). The ubiquitous eel appears in catches in all zones.

Power plant operations may impact on finfish populations by: (1) entraining fish eggs and larvae; (2) killing adults or juveniles by impingement on intake screens; (3) causing mortality of adults due to discharge effects; and (4) decreasing food abundance for various life stages (Richkus and Lippson, 1975). (Also see Section I.)

(1) Entrainment

In the Morgantown sampling programs, too few fish eggs were taken to evaluate entrainment effects on eggs, but our studies indicate that fish larvae passing through Morgantown plant suffer extensive mortality (Mihursky et al., 1973b; Richkus and Lippson, 1975). Although the species of larvae and their developmental stage may strongly influence the magnitude of entrainment-induced mortality (Marcy, 1973), fish larvae entrainment mortalities of 50-100% are generally to be expected (Butz et al., 1974). Thus, the potential impact of entrainment of ichthyoplankton of commercial species at the Morgantown SES is a function of the number of ichthyoplankton of these species susceptible to entrainment.

Very low densities of ichthyoplankton were observed in the Morgantown area during PPSP-sponsored entrainment studies (Bongers et al., 1973; Mihursky et al.,1973b). In May 1973, average transect densities were below 22 per 1000 m^3, with one exception where densities reached 298 per 1000 m^3. These densities are extremely low when compared to mean larval densities of 28,700 per 1000 m^3 estimated for all species in the major spawning region of the Potomac in spring, 1973 (EAI, 1974). At the end of the anadromous fish spawning season, the mean larval density near Douglas Pt., upstream of Morgantown,was only 1,100 per 1000 m^3, with a single transect density up to 3,341 per 1000 m^3. In 1973, at the Vienna SES on the Nanticoke River, Md., larval densities during the spawning season at a major striped bass spawning area reached 24,000 per 1000 m^3 (Mihursky et al., 1973a). Larval densities as high as 250 per 1000 m^3

have occurred at Morgantown during the summer (Mihursky et al, 1973b) but include estuarine species which are not commercially important except, perhaps, as forage fish for more valuable species.

Specific evaluation of the probability of entrainment of early life stages of commercially important species supports the conclusion that chances of entrainment mortality due to Morgantown SES are low.

(a) Striped Bass

The center of striped bass spawning activity is about 15 mi above Morgantown. Because factors controlling spawning behavior are not fully understood, however, downstream spawning could occur occasionally. Nevertheless, with the general spawning patterns that have been observed to date, it can be concluded that entrainment of eggs or larvae at the Morgantown SES will have no substantial adverse effect on the striped bass population.

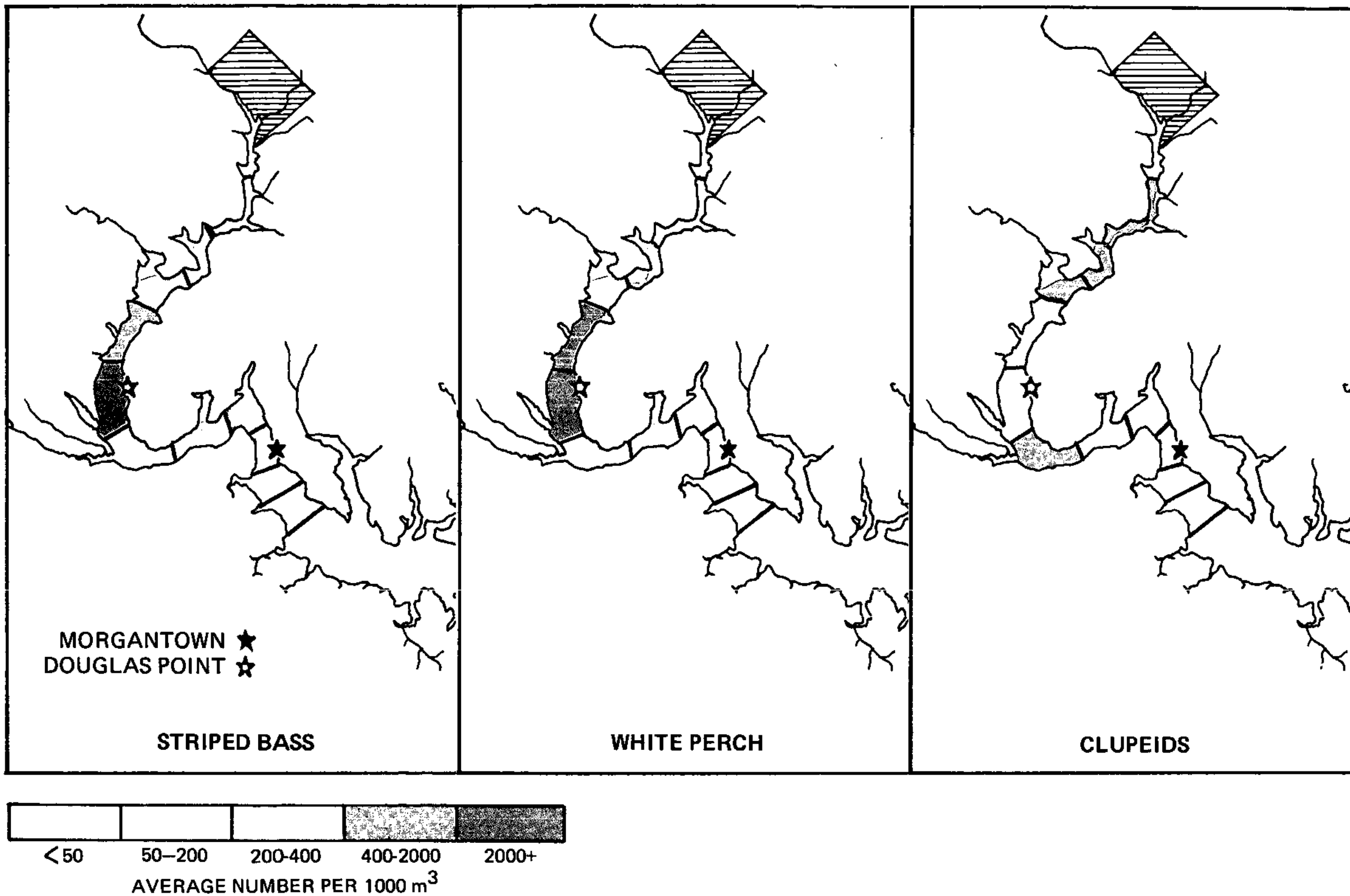
(b) White Perch

The white perch is an abundant and ubiquitous anadromous species which spawns in nearly all Chesapeake Bay tributaries (Musick, 1972). No white perch eggs and larvae have been observed at Morgantown during PPSP studies, but large densities (as high as 47,088 per 1000 m^3) were found at Maryland Point about 14 mi above Morgantown, in early May 1973 before spring entrainment studies at Morgantown SES began (EAI, 1974). The highest numbers of white perch eggs and larvae in the 1974 river survey were found between Stuart Point (just below Maryland Point) and Piscataway Creek, river mile 89.5 (Mihursky et al., 1974a, b; EAI, 1974) (Figure VII-15). Since Morgantown is downstream of the main spawning areas, the overall effect of plant entrainment on the white perch population can be expected to be insignificant.

(c) Alewives and Shad (Clupeid Species)

Distributions of clupeid eggs and larvae have not been identified by species in most Potomac River ichthyoplankton surveys. Initial peak concentrations of clupeid larvae in 1972 and 1973 surveys were found at Maryland Point and shifted upstream in later weeks (NUS, 1973). In the 1974 survey (Mihursky et al., 1974a, b), high concentrations of eggs and larvae were also observed at Maryland Point (Figure VII-15), and a few larvae were taken at Morgantown in early April. Later surveys revealed distributions centered above Maryland Point (above river mile 53).

Based on these data, high concentrations of clupeid larvae can be expected around Maryland Point in the spring and some clupeid larval entrainment at Morgantown. However, the plant is located at a marginal location with respect to the larval distributions and would not be expected to entrain a significant portion of the total eggs and larvae produced.



VII-15. Average number of eggs and larvae of striped bass, white perch, and clupeids collected in sample segments of the Potomac River during the 1974 ichthyoplankton survey. Source: Mihursky et al., 1974.

(d) Menhaden, Spot, American Eel, Catfish

Since menhaden, spot, and eel are ocean spawners, their early life stages are non-pelagic late larvae or juveniles by the time they reach Morgantown (Lippson and Moran, 1974). The catfish is primarily a freshwater resident and spawner. Thus, entrainment of eggs and larvae of these species is unlikely, and no impact on these populations from entrainment mortalities would occur.

(2) Impingement Mortality

There are no records of numbers and species of fish impinged on intake screens at the Morgantown SES. No fish kills have been reported at the site since the plant went on-line in 1970, but there is a possibility that some small kills due to impingement have gone unnoticed. The large numbers of fish, mostly young menhaden and spot, observed in the Morgantown intake embayment in the summer (Bongers, personal communication, 1973) present a potential for impingement mortality: a drop in dissolved oxygen levels of the intake water in mid-summer could physiologically impair fish in the embayment, making them liable to impingement. Similar concentrations were not observed in the winter, suggesting that well-documented major winter fish kills due to impingement at other power plants (Edsall and Yocum, 1972) are not likely at Morgantown.

Since there have been no recorded impingement kills at Morgantown, the probability of such events can be probed only by determining if fish species involved in impingement kills reported elsewhere are present at the plant. Most major fish kills due to impingement at estuarine plants have consisted of juvenile white perch and menhaden, rather than adults (Edsall and Yocum, 1972; Clark and Brownell, 1973). There also appears to be some correlation between numbers of fish impinged and volume of cooling water used, regardless of intake velocity (Clark and Brownell, 1973).

The Morgantown plant is not located at a site in the estuary at which major concentrations of juvenile white perch and menhaden occur. A 1974 survey of the Potomac from June through September found white perch distributed throughout the river, but concentrated primarily above Maryland Point. Menhaden were also distributed throughout the estuary, but largest concentrations were found in the upper reaches of tributaries such as Nanjemoy and Potomac Creeks (river miles 53.5 and 59.5, respectively) (Loos, 1975). These populations would be expected to move past Morgantown in the fall, but no records exist to document this migration.

No major concentrations of juveniles of the commercially important species have been found to occur at Morgantown. Significant concentrations of the freshwater catfish or eels have not been found at the plant site (Scott and Boone, 1973; ANSP, 1970b). The number of juvenile spot observed in the Morgantown intake embayment reflects the general increase in spot population in the Chesapeake Bay in the last several years (Richkus, 1975), but Morgantown is not considered an area of major spot concentrations. Juvenile striped bass were taken throughout the river during the MFA surveys (Scott and Boone, 1973), although wintering populations were not sampled. However, no large numbers of juvenile striped bass appeared in winter. trawl samples taken by ANSP (1970b).

Juvenile shad were found only at upper Potomac stations (Scott and Boone, 1973). While these populations move seaward through the remainder of the estuary, their passage past Morgantown is so rapid that the chances of a major portion of the population being impinged are small (Chittenden, 1969). Juvenile alewives are taken throughout the estuary (Scott and Boone, 1973), but no consistent major concentrations have been observed in the Morgantown area.

Since the sampling method (seining) used to obtain the juvenile distributions presented here may not have accurately sampled whole populations, further impingement data must be obtained from the Morgantown plant in order to fully evaluate its impact on finfish. However, the absence of major impingement-related kills at Morgantown suggests that impingement is not a source of fish mortality.

(3) Discharge-Related Mortalities

Numerous discussions have been presented concerning the possible effects of power plant discharges on finfish populations (Coutant, 1970; Edsall and Yocum, 1972; Clark and Brownell, 1973). Table VII-8 shows major discharge-related kills and their probable causes.

No discharge-related kills have been recorded at the Morgantown plant since it went on-line. However, as with impingement effects, only a kill of large magnitude would probably be noticed and reported; thus, the lack of reported kills does not demonstrate that none has occurred. The only data available from PPSP-sponsored studies relevant to discharge-related effects are acoustic survey data collected in April and May, 1974 (Zankel et al., 1975). Survey data collected on 11 April 1974 indicated that there were fish accumulations in the discharge plume area. However, without environmental data to determine the conditions under which the fish distribution patterns were obtained, and without groundtruth netting information to identify species composition of the aggregation, the data are of limited value.

From the data given in Table VII-8, it is evident that major discharge-related fish kills have been caused primarily by chlorine and cold shock. Fish are usually able to avoid immediately fatal concentrations of chlorine (Clark, 1972). Tests with white perch, alewives, mummichogs and hogchokers -- all typical estuarine species -- showed that they avoided immediately lethal doses (from 0.3 ppm to 2.0 ppm) (Meldrin et al., 1974), but did not avoid very low levels (<0.3 ppm) which were within their chronic toxicity thresholds (Lauer, 1972). At Morgantown, free chlorine concentrations

TABLE VII-8 Discharge-related mortality events at power plants located on estuarine waters.[1]

POWER PLANT	EVENT	DATE	SOURCE	COMMENTS
Oyster Creek, Barnegat Bay, N.J.	100,000-200,000 menhaden killed	Jan. 28-30, 1972	71,72,73	Cold shock following winter plant shutdown. Fish were resident in plume. Approximately 25°F drop in temperature.Continuing winter 1973.
Northport, Long Island Sound, N.Y.	10,000 bluefish killed	Jan. 17, 1972	74	Cold shock caused by sudden shifting of plume (ΔT 25°F) due to winds and tide. Fish resident in plume exposed to cold. Bodies on bottom; count made by diver.
Millstone Point, Long Island Sound, N.Y.	tens of thousands of adult menhaden killed	Spring, 1972	75	No reason given (we suspect nitrogen gas embolism--authors).
Turkey Point, Biscayne Bay, Fla.	thousands of dead fish	June 26, 1969	76	High temperature shock, apparently. Plant discharge temperature 95-100°E
Lovett, Hudson River, N.Y.	1,000 fish killed	June 7, 1971	77	Species not given. Power plant caused. Lovett assumed responsible; closed plant to Thompkins Cove, where reported.
P.H. Robinson, Galveston Bay, Texas	significant kill of menhaden	Aug. 21, 1968	78	Unknown quantity. Cause given as high temperature shock.
Pilgrim, Cape Cod Bay, Mass.	from "thousands" to 75,000 or more adult menhaden		79	Smithsonian report, 1,000's; press, "...fight for life...school in excess of 75,000." Apparent cause nitrogen embolism.
Cape Cod Canal, Cape Cod Canal, Mass.	kill of several hundred to several thousand menhaden per treatment	Aug./Sept., 1968	80	Chlorine treatment (residual Cl=0.8--1.5ppm) twice daily; kills occurred at high water slack.
	repreated mortality of large schools of silversides and menhaden	late summer, 1968	81	Near discharge; lethal temperatures 90-94°F; predation by gulls.
Chalk Point, Patuxent River, Md.	40,000 blue crabs killed, minimum		82	Cause not determined; probably chlorine.

[1] (Clark and Brownell, 1973)

at the point of discharge into the river tend to be less than 0.01 ppm, a level roughly at or below chronic toxicity thresholds for most species.

The other common cause of discharge-related kills, cold shock, occurs when fish in a heated discharge during late fall and winter are exposed to a sudden temperature drop when the plant shuts down. There is no information available on fish concentrations near the Morgantown discharge in winter, so that no conclusions can be drawn about the possibility of such kills occurring at the plant site. However, the scheduling of regular shutdowns at times other than winter would appear to minimize the likelihood of any incidents.

(4) Propagative Effects

It is extremely difficult to evaluate the effect of decreases in forage species on finfish populations. This is especially true when a particular predator feeds on a large variety of organisms and may merely shift its concentration of effort from one type of prey to another if the population of the first declines. Both populations of primary producers (phytoplankton and zooplankton) and of forage species (anchovies, silversides) for commercially important species are so prolific and ubiquitous throughout the river that any depredations due to power plant effects would not be felt through the rest of the food chain.

4. Benthic Organisms

a. Resources

Benthic invertebrates in the Potomac include the commercially valuable resources:

(1) Blue crabs;
(2) Oysters;
(3) Edible clams;

and noncommercial but ecologically important species (Frey, 1946; Pfitzenmeyer and Drobeck, 1963, 1964; Dunnington et al., 1974; Pfitzenmeyer, 1974; Polgar et al., 1975):

(1) Small crustaceans (amphipods, isopods, decapods);
(2) Noncommercial clams (bivalves);
(3) Worms (oligochaetes, polychaetes, nematodes);and
(4) Encrusting organisms (bryozoans).

Benthic invertebrate communities at Morgantown (located near the boundary between oligohaline and upper mesohaline zones) (Figure VII-1) are largely composed of estuarine species with broad salinity tolerances (between 2 and 10 ppt). Few comprehensive surveys of the benthic communities at Morgantown or elsewhere on the Potomac River estuary have been conducted (Frey, 1946; Pfitzenmeyer and Drobeck, 1963, 1964; Pfitzenmeyer, 1974; EAI, 1974; Polgar et al., 1975). However, from those studies which do exist, species distributions at Morgantown appear to be typical of mesohaline zones in other tributaries of the Chesapeake Bay (Pfitzenmeyer, 1970; Boesch, 1971, 1972, 1974) and other temperate-zone estuaries (Sanders et al., 1965; Tenore, 1972). Table VII-9 lists the dominant benthic species at Morgantown, their mode and season of reproduction, general habitat preference, and salinity tolerances.

Salinity has been shown to be the most important environmental factor affecting the distribution of benthic invertebrates throughout the length of estuaries (Gunter, 1961; Sanders et al., 1965; Kinne, 1966; Tenore, 1972; Boesch, 1971, 1972, 1974; Pratt, 1973). Magnitude of salinity variation, rate of change, and duration of exposure have all been shown to be critical factors in distributional patterns (Alexander et al., 1935; Sanders et al., 1965; Carriker, 1967; Boesch, 1971). In general, the more uniform and constant the salinity regime, the broader a given species' salinity tolerance and distributional range will be. However, lateral benthic invertebrate distribution pattern within a salinity zone is affected by other environmental factors (e.g., substrate type, dissolved oxygen, hydrography) (Sanders, 1958, 1960; Tenore, 1972; Polgar et al., 1975).

Substrate type determines community structure differences in any segment of the river. Three major substrate types have been recognized (i.e., sand, silt-clay, and shell), each with a characteristic assemblage of benthic invertebrates (Polgar et al., 1975). Table VII-10 summarizes the structure of benthic invertebrate communities in the Morgantown region of the Potomac, other tributaries of the Chesapeake Bay, and another temperate-zone gradient estuary.

Because most benthic organisms have limited mobility throughout most life stages, they are unable to retreat from environmental perturbations and thus are continually exposed to natural and man-induced environmental changes. Structural complexity (i.e., number of species and distribution of individuals of benthic communities) is considered to be a good indication of prevailing environmental conditions (Gray, 1971; Polgar et al., 1975). Species diversity at Morgantown is comparable to that in other areas.

Of the commercially important benthic species in the Potomac, the soft-shelled clam has been observed as far upstream as Port Tobacco Creek, the dividing point between the mesohaline and oligohaline zones of the Potomac (Pfitzenmeyer and Drobeck, 1963), but it is not a dominant species at Morgantown.

A number of oyster bars are located in the Morgantown area, their farthest upstream penetration. Only 8 mi downstream from the plant (Swan Point), where mesohaline conditions also exist, environmental factors are most conducive to oyster growth, and oyster growth rates have been historically high (Frey, 1946; Beaven, 1958; Dunnington 1974; Dunnington et al., 1974). However, none of the oyster bars located in this area (Figure VII-16) are currently productive due to the effects of hurricane Agnes in 1972.

TABLE VII-9

Biological Characteristics of Benthic Invertebrates*

Species Name	Habitat Preference	Reproductive Type	Reproductive Season	General Feeding Type	Salinity Tolerance	Salinity Preference	Upper Thermal Tolerance Adults	Upper Thermal Tolerance Dev. Stages
AMPHIPODS								
Corophium lacustre	Fouling organism on hard substrates	Brooded young	May-Sept. several broods	Deposit feeder	2.5-25.0 ppt	2-10 ppt	30°C	-
Leptocheirus plumulosus	Tube dweller in sandy and muddy habitats	Brooded young	May-Sept. several broods	Omnivore	0.5-15.0 ppt	2-10 ppt	30°C	-
ISOPODS								
Cassadinidae lunifrons	Shell limited species	Brooded young	May-Sept.	Omnivore	5.0-33.0 ppt	-	30°C	-
Cyathura polita	Tube builder in all substrates - dominant in sandy substrates	Brooded young	May-Sept.	Omnivore	2.5-35.0 ppt	10.1-15.0 ppt	>35°C	-
CIRRIPEDS								
Balanus sp.	Shell limited fouling organism	Pelagic larvae	Spring-Fall spawner several broods	Filter feeder	2.5-10.0 ppt	-	>35°C	>35°C
POLYCHAETES								
Scolecolepides viridis	Ubiquitous Chesapeake Bay polychaete	Pelagic larvae	March-April	Deposit feeder	0.5-35.0 ppt	15.0 ppt	32°C	-
Heteromastus filiformis	Tube dweller in all substrates - dominant in sand	Semi-brooded young	Fall	Deposit feeder	0.5-35.0 ppt	5-18 ppt	>35°C	-
Nereis succinea	Ubiquitous Chesapeake Bay polychaete	Semi-brooded young	June-Sept.	Omnivore	0.5-35.0 ppt	5-18 ppt	>35°C	-
MOLLUSKS								
Macoma balthica	Burrowing species in muddy substrates	Pelagic larvae	Mar.-June and Sept.-Nov.	Deposit feeder	2.5-35.0 ppt	15 ppt	32°C	34°C
Rangia cuneata	Burrowing species in sandy and muddy substrates	Pelagic larvae	Spring-Summer	Filter feeder	0.5-35 ppt	2.0-10.0 ppt	>39°C	33°C

* Summary of some of the biological characteristics of the dominant benthic invertebrate species inhabiting the upper mesohaline region of the Potomac River estuary near the Morgantown SES.

Ref.: Polgar, et al., 1975